New exploration datasets for the western Arunta: could this be the next Olympic Dam?

by

CV Spaggiari, PA Morris, and IM Tyler

The Arunta Orogen is an integral part of the North Australian Craton (NAC), which is largely made up of Paleoproterozoic orogens and basins (e.g. Myers et al., 1996; Tyler, 2005). The western part of the Arunta Orogen (Fig. 1), which lies within Western Australia, is one of the least-studied components of the NAC, largely because of its remoteness and restricted access. However, limited previous work has reported the potential for significant Cu–Au mineralization (Wyborn et al., 1998). In 2007 GSWA embarked on an integrated survey to test this hypothesis, and to gain insight into the geological relationships in the region. The survey consisted of a helicopter-assisted regolith-geochemistry sampling program, coupled with a targeted field study of outcrop geology, which was also assisted by helicopter and included whole-rock geochemistry and geochronology sampling, and geophysical interpretation utilizing a new 2.5 km spacing gravity dataset. Sampling and surveying covered a large part of the WEBB* 1:250 000-scale map sheet, the northern part of MACDONALD, and the southeast corner of WILSON (Fig. 1). The field survey and geophysical interpretation has allowed identification of a substantial hydrothermal system located along a major structure that links to the Central Australian Suture, which has been mapped on adjacent map sheets across the border within the Northern Territory (Scrimgeour et al., 2005). This includes the area where alteration (including sodic–calcic, sericitic, and hematite–K-feldspar) associated with Mount Webb Granite has previously been described (Wyborn et al., 1998).

Geological overview

In the western part of the Northern Territory the Arunta Orogen is divided into the 1870 to 1710 Ma Aileron Complex in the north and the 1690 to 1600 Ma Warumpi Complex in the south (Scrimgeour et al., 2005). The Willowra Gravity Ridge separates the Aileron Complex from the Granites–Tanami Orogen to the north. This is partly coincident with an aeromagnetic low, and may represent a fossil (≥1864 Ma) suture zone. The Aileron Complex in the western Arunta (Fig. 1) contains polydeformed psammitic and pelitic rocks that are probably part of the Lander Rock Formation (c. 1835 Ma), and deformed and strongly recrystallized quartzites that may correlate with the Reynolds Range Group (1805–1770 Ma). To the west, sparsely outcropping interbedded banded iron-formation (BIF) and psammitic rocks correspond to major highs in the aeromagnetic data, but it is not clear where this unit fits in to the stratigraphy (Fig. 1). Aeromagnetic highs in the northern part of the survey area may indicate more extensive occurrences of these rocks; but outcrops are mostly of non-magnetic quartzites, which may be a thin cover over the magnetic rocks. The magnetic rocks flank strongly deformed granitic rocks of unknown age to the east and south.

The Warumpi Complex is divided into three domains of variable metamorphic grade, with the greenschist facies Kintore Domain extending into the western Arunta (Close et al., 2006). On the Northern Territory side of the border 1690 to 1670 Ma granitic intrusions and 1630 Ma felsic volcanic rocks are present. In the western Arunta within Western Australia three samples of Mount Webb Granite gave SHRIMP U–Pb zircon ages of 1643 ± 4, 1639 ± 5, and 1639 ± 5 Ma, and dacitic volcanic rocks of the Pollock Hills Formation gave a tentative igneous crystallization age of c. 1640 Ma, interpreted as coeval with the granite (Wyborn et al., 1998).

At this stage it is not clear which stratigraphic units mapped in the Arunta Complex within the Northern Territory correlate with those in the western Arunta within Western Australia, but new geochronological and geochemical data (in progress) may help resolve these issues. However, aeromagnetic imagery suggests that at least some of the units, from both the Aileron and Warumpi Complexes, extend from the Northern Territory into Western Australia.

The Warumpi Complex is interpreted as a >500 km-long exotic terrane that was accreted to the southern margin of the Aileron Complex during the 1640 to1630 Ma Liebig Orogeny (Scrimgeour et al., 2005; Close et al., 2006). The two complexes are separated by a series of major faults, including the Redbank Thrust, collectively

* Capitalized names refer to standard 1:250 000 map sheets, unless otherwise indicated.

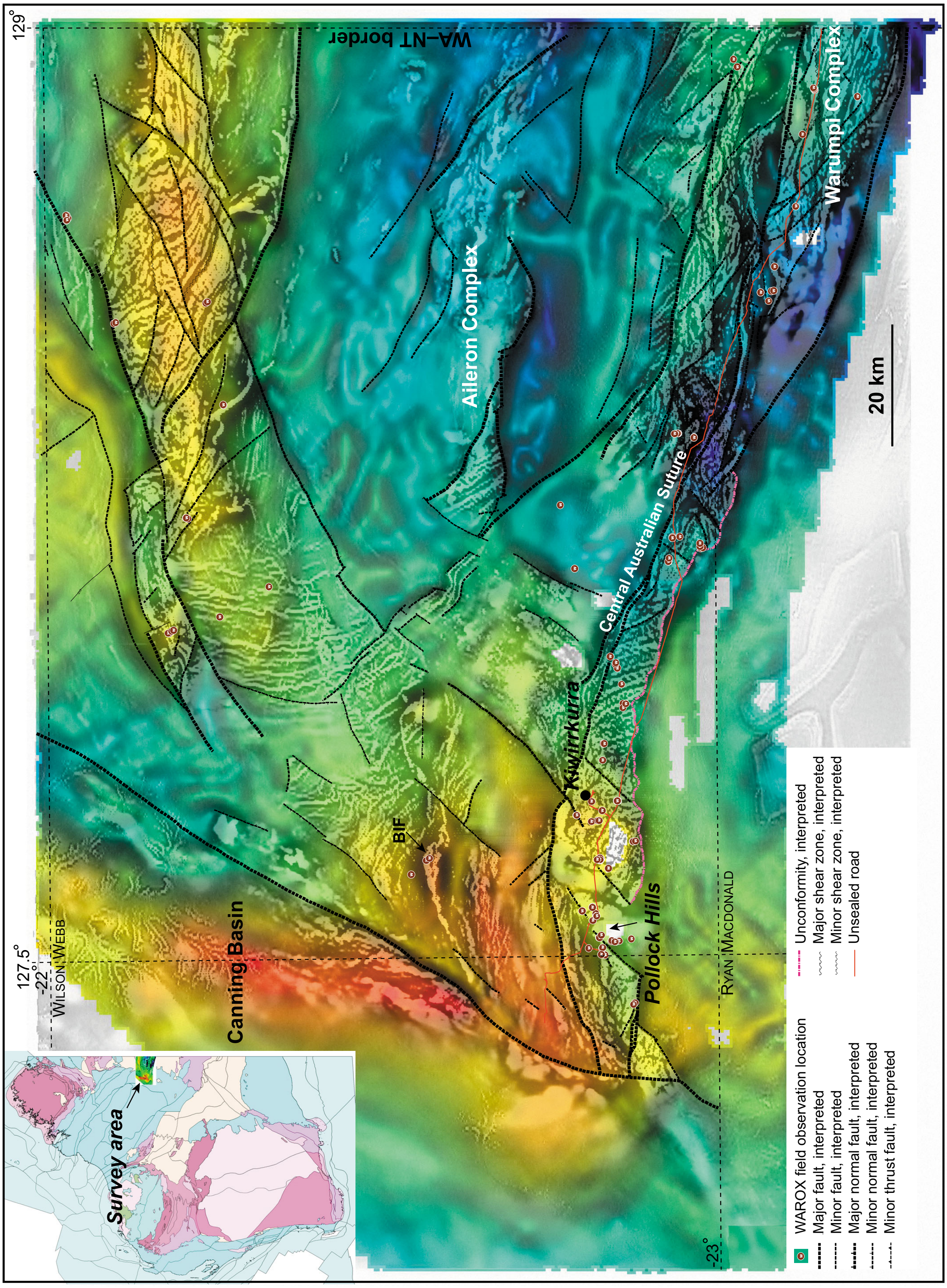

Figure 1. **Interpretation of major structures and tectonic units of the western Arunta, showing outcrop locations of field observations (WAROX database). The background image is a drape of first vertical derivative aeromagnetic data over 2.5 km-spaced gravity data (GSWA–Geoscience Australia datasets). The inset shows the location of the survey area in Western Australia**

Figure 2. Radiometric image with regolith geochemistry sample locations (dots) and major structures, as in Figure 1

termed the Central Australian Suture (Scrimgeour et al., 2005). Although the suture first formed during the Liebig Orogeny, the structures have clearly been reactivated, probably during the c. 550 Ma Petermann Ranges Orogeny and the 450 to 300 Ma Alice Springs Orogeny. The fault system associated with the Central Australian Suture continues across the Northern Territory border into the western Arunta where it shows up clearly in the geophysical data, and mylonitic rocks along its trace are common (Fig. 1). This structure, and some others, are also delineated in the radiometric data (Fig. 2), which suggests that the regolith cover is reasonably thin and locally derived (see below). Fault rocks affected by large volumes of fluid crop out just south of the Central Australian Suture, and also adjacent to the Mount Webb Granite. The protoliths of these rocks are unrecognizable in the field due to hydrothermal alteration, but there is some indication that they may have been granitic and dacitic rocks. They contain quartz stockwork veining, hydrothermal brecciation with jigsaw fit, biotite veins, and cataclastic textures.

The basement rocks are unconformably overlain by sedimentary rocks, including the upper Pollock Hills Formation, the Neoproterozoic Heavitree Quartzite and Bitter Springs Formation of the Amadeus Basin, and the Munyu Sandstone of the Redcliff Pound Group to the north. These have been folded at least once and are also cut by various faults, including inferred south-dipping thrusts. Whether other units are present is unknown, but new geochronological data on detrital zircons may help resolve this. Undeformed Paleozoic sandstones, pebbly sandstones, and conglomerates overlie the Amadeus Basin rocks. The cover rocks correlate with long wavelength features in the aeromagnetic data and, combined with the gravity data, show up as ‘holes’, created by late normal faults against the basement (Fig. 1) during formation of the Canning Basin to the west.

Regolith and regolith geochemistry

Regolith covers approximately 80% of the project area. WEBB is dominated by flat to weakly undulating sandplain with elongate sand dunes. The distribution and type of dunes varies between areas characterized by widely spaced (kilometre-scale) dunes several kilometres long, and areas featuring closely spaced net-dune systems. The utility of regolith as a sampling medium in mineral exploration depends on its thickness, composition, and relationship to the underlying bedrock. The interpretation of remotely sensed data coupled with observations about the grain size, sorting, and mineralogy of regolith recorded at each of more than 500 regolith geochemistry sampling sites (Fig. 2) have been used to map out different regolith types, and interpret their origin.

In the few road gravel quarries and flood washouts where regolith–bedrock relationships can be seen, the sandplain is between 1.5 and 2.5 m thick. These thicknesses are consistent with the results of a 731-hole aircore drilling program (Fitzgerald, 1998) carried out in the Pollock Hills – Mount Webb areas (Fig. 2), which showed that 91% of holes reached the bedrock–regolith interface at depths of less than six metres, and 79% of the interfaces were at a depth of less than four metres. The thickest regolith intersection was 36 m. This suggests that the extensive sandplain cover is a thin veneer with a locally derived component.

The majority of the regolith samples collected are from an east–west corridor bracketing Pollock Hills and Mount Webb, and covering the Central Australian Suture (Fig. 2). At each site, approximately 4 kg of material was collected from a depth of approximately 25 cm, thus avoiding any surface windblown sand. The majority of the samples consisted of well-sorted quartz-dominated sand with between 5 and 40% clay. Ferruginous granules, ferruginized lithic fragments, or weathered bedrock grains were observed at almost all sites, and ferruginized deflation lag was seen in some areas, but was not common.

Most regolith samples contain either ferruginized lithic fragments or granules, or weathered bedrock fragments, apart from those in areas of net dunes, where the sand cover is thicker, and ferruginized or weathered lithic material is less common. From these observations it is likely that the sandplain is, in part, of local origin, with superimposition of sand dunes during an arid climatic phase. In general, the sandplain and more closely spaced dune systems are better developed in areas of sandstone or quartzite bedrock.

The <2 mm fraction of each of the samples was digested with aqua regia, and analysed by ICP for 45 elements. This digestion approach largely excludes the silicate fraction (in this case, quartz sand) the inclusion of which would result in element dilution.

Mineralization potential

Relatively little is known about the economic mineral potential of the western Arunta, but there are indications of Cu–Au mineralization including Fe-oxide Cu–Au (IOCG) deposits. Certain key criteria are present in the region that can contribute to formation of major deposits: major, deep-seated structures (i.e. the Central Australian Suture, and its reactivation), magmatism of a similar age to initial formation of the major structures, and hydrothermally altered fault rocks with stockwork and breccia textures. Although further work is required, these features, and the presence of magnetite-rich granitic and volcanic rocks with alteration styles including sodic–calcic, sericitic, and hematite–K-feldspar (Wyborn et al., 1998) all suggest potential for IOCG deposits. There is also the potential for mineralization associated with hydrothermal fluid flow driven along reactivated large-scale structures such as the Central Australian Suture, during the later formation and inversion of the Amadeus Basin (Fig. 1).

Conclusions

The survey undertaken in 2007 has provided insight into the regional geology of the western Arunta, and how it can potentially link up with that established across the border in the Northern Territory. It has demonstrated the effectiveness of a targeted and integrated survey program, the results of which will hopefully inspire some much-needed greenfields exploration in the area.

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